Report of Proceedings

Cotton Utilization Research Conference

May 3 and 4, 1962

Southern Utilization Research and Development Division
Agricultural Research Service
U. S. Department of Agriculture
New Orleans 19, Louisiana

C. H. Fisher, Director

This report summarizes the discussions of the various speakers during the conference. If further details regarding any particular subject are desired, they may be obtained by communicating with the person concerned.

COTTON UTILIZATION RESEARCH CONFERENCE

New Orleans, Louisiana

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UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
SOUTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

COTTON UTILIZATION RESEARCH CONFERENCE

May 3-4, 1962

Fontainebleau Motor Hotel
New Orleans, Louisiana

HONORARY CHAIRMAN
Dr. M. Earl Heard
West Point Manufacturing Company
Shawmut, Alabama

GENERAL CHAIRMAN
Sydney M. Cone, Jr.
Cone Mills Corporation
Greensboro, North Carolina

CO-CHAIRMAN
E. L. Patton
Assistant Director
SURDD

May 3, 1962 - 9:15 A.M.
Hotel Ballroom

Opening Remarks	M. Earl Heard
Introduction	Sydney M. Cone, Jr.
Welcome	C. H. Fisher, Director, SURDD

Presiding: Leonard Smith, NCCA, Washington, D. C.

Present Status of Crystallinity in Plant Fibers	Mary L. Nelson Plant Fibers Lab., SU
Applications of Spectroscopy to Cotton Research	V. W. Tripp Cotton Phys.Prop.Lab., SU

Intermission

Wrinkle-Resistant Properties of Chemically Modified Dialdehyde Cotton Fabric	Charles H. Mack Cotton Chem.Reac.Lab., SU

May 3, 1962 (cont.)

Multipurpose Finishes for Cotton Based on Divinyl Sulfone Derivatives	Clark M. Welch Cotton Chem.Reac.Lab., SU
Panel Discussion	Lee Wayland, Moderator Dan River Mills Danville, Virginia

LUNCH

May 3, 1962 - 2:00 P.M.

Presiding: John Elting, The Kendall Co., Charlotte, N. C.

Radiation-Induced Reactions of Cotton Cellulose	Jett C. Arthur Cotton Chem.Reac.Lab., SU
A New, Durable Wash-Wear Finish for Cotton	J. G. Frick, Jr. Cotton Finishes Lab., SU

Intermission

Stretch Cotton Fabrics by Slack Mercerization	A. S. Cooper, Jr. Cotton Finishes Lab., SU
Progress Report on the Carbamate Wash-Wear Finish	J. D. Reid Cotton Finishes Lab., SU
Panel Discussion	Linton Reynolds, Moderator Riegel Textile Corp. Ware Shoals, S. C.

6:00 P.M. Social Hour (Dutch Treat)

7:00 P.M. Dinner (Tickets to be sold)

May 4, 1962 - 9:00 A.M.
Hotel Ballroom

Presiding: Earl E. Berkley, Deering and Milliken Service Corp., Spartanburg, S. C.

Research to Improve Cotton Batting	H.L.E. Vix Eng. and Dev. Lab., SU
What's in the Mill for Wool	R. E. Whitfield WURDD
Effect of Spinning Variables on Cotton Product Properties	John D. Tallant Cotton Mech. Lab., SU

Intermission

Effect of Fiber Strength on Spinning Performance	W. T. Waters Auburn University Auburn, Alabama
The SRRL Ringless Spinning Machine	George J. Kyame Cotton Mech. Lab., SU

LUNCH

May 4, 1962 - 1:00 P.M.

Stretch and Bulky Cotton Yarns and Fabrics Through Mechanical and Chemical Treatments	John J. Brown Cotton Mech. Lab., SU
The SRRL Non-Lint Tester	Ralph A. Rusca Cotton Mech. Lab., SU
Panel Discussion	E. V. Painter, Moderator Johnson & Johnson Chicago, Illinois

Tour and Exhibits of Cotton Research (Busses courtesy Southern Utilization Research and Development Division)

PRESENT STATUS OF CRYSTALLINITY IN PLANT FIBERS

by
Mary L. Nelson
Plant Fibers Pioneering Research Laboratory
Southern Utilization Research and Development Division
New Orleans, Louisiana

Theories of the structural arrangement of the crystalline phase in native fibers, so important to our understanding of fiber technology, have evolved from the micellar theory through the continuous-structure concept to the present idea of a modified fringe-micelle structure having a range of degrees of crystal perfection or "lateral order." Various techniques for studying the crystalline structure will be discussed with regard to the type of information they give, and their application to a particular problem will be shown briefly.

Improvements in x-ray diffraction apparatus in recent years allow rapid determination of crystal lattice type to show extent of mercerization or other intracrystalline lattice changes. The approximate degree of crystallinity can be calculated by at least two methods from the same kind of diffractograms. Some data from a recent study will illustrate the usefulness and limitations of these measurements. A third parameter which can be calculated from these diffractograms, the approximate dimensions of crystallites, has not been used much for plant fibers. A fourth use of x-rays for plant fibers is in measuring orientation of the fibrils— a parameter known for many years to be highly correlated with strength of cotton.

A different kind of information on the amount of crystalline material in fibers is obtained from density measurements. This useful and simple technique gives a value for crystallinity based on the assumption that all material in the fiber is either crystalline or amorphous and that the specific volumes of these two phases are additive. The correlation of density data with x-ray crystallinities will be shown and some of the pitfalls of density measurements will be pointed out.

The accessibility of a cellulosic fiber, defined as the fraction available for moisture sorption, is not synonymous with the amorphous fraction, since the surfaces of crystallites are accessible to moisture. The accessibility is, however, a better measure of potential reaction sites than the values of crystallinity, especially for such reactions as cross-linking in which the crystallites normally are not penetrated. A simple equation (L. Valentine, Chem. & Ind., Nov. 3, 1956, p. 1279) permits calculation of the accessible fraction. Values for a series of cotton and rayon samples will be graphically compared with crystallinity data from x-ray and density measurements.

Infrared spectra afford a means of judging the average degree of molecular ordering by the relative intensities of absorption bands due to vibrations of atoms in the molecule. This type of measurement gives insight at a

different level of molecular organization than does x-ray. O'Connor's infrared crystallinity index (ratio of absorbances at 7.0 and 11.2 microns) has shown excellent correlation with x-ray crystallinity in a series of native cotton samples whose crystallinity had been artificially reduced, but it is not applicable to mercerized or partly mercerized cottons. An infrared ratio based on relative intensities of two other absorption bands (7.3 and 3.45 microns) will be shown to be correlated with crystallinity in mercerized cottons and rayons as well as in native cottons. It is proposed to use this ratio in current and future studies of changes in crystallinity of cotton fibers during growth or after various treatments.

APPLICATIONS OF SPECTROSCOPY TO COTTON RESEARCH

by

Verne W. Tripp and Robert T. O'Connor
Cotton Physical Properties Laboratory
Southern Utilization Research and Development Division
New Orleans, Louisiana

The characterization of polymers, textiles, and related materials by analytical spectroscopy has received increasing attention in recent years. The chief reasons for the active application of analytical procedures involving spectroscopy are the development of reliable and rapid instrumentation in methodology and the realization that it would be only through such techniques that vitally important information for product development could be obtained. At the present time, radiation of wavelengths ranging from 0.1 Angstrom unit to several meters is being used to provide both basic and commercially necessary data on the materials of the textile industry.

Of the forty-odd branches of analytical spectroscopy, some 15 to 20 have been or are being actively employed to characterize textile products. These techniques include x-ray fluorescence, absorption, and diffraction, ultraviolet emission (spectrochemical analysis), fluorescence and absorption, Raman scattering, flame photometry, absorption and reflectance in the visible region, infrared and microwave absorption, and nuclear magnetic and electron spin resonance absorption. Many of these are being applied specifically to cotton research. In particular, infrared absorption of cellulose modifications in the solid state and x-ray fluorescence have been especially useful in cotton research at the Southern Utilization Research and Development Division.

Infrared spectroscopy of cotton derivatives in the solid state is a sensitive tool for the identification of the products of many simple and mixed ester, ether, and hydroxyl replacement reactions. In favorable cases, quantitative estimation of the degree may be obtained. In reactions with N-methylol reagents to impart wash-wear characteristics to cotton, absorption bands have been found for the qualitative and quantitative analysis of these products. Of equal importance, infrared spectra of these cotton modifications have been of value in determining the chemical structure of the derivatives.

The rapid and accurate determination of both metals and non-metals in cotton products by x-ray fluorescence techniques has permitted the time required for these analyses by classical methods to be reduced to a remarkable degree. This method is suitable for nearly all of the elements with atomic numbers of 15 or greater. It has been of particular value in the determination of such elements as copper, cadmium, mercury, and selenium in finishes used for weather- and rot-resistance, and shows promise for routine analyses of the halogens (except fluorine), sulfur, phosphorus, titanium, and other elements important in cotton chemical finishing.

THE WRINKLE RESISTANT PROPERTIES OF CHEMICALLY MODIFIED DIALDEHYDE COTTON FABRIC

by
Charles H. Mack and Clinton P. Wade
Cotton Chemical Reactions Laboratory
Southern Utilization Research and Development Division
New Orleans, Louisiana

Dialdehyde cotton fabric was prepared by oxidizing cotton print cloth with periodic acid at pH 1.2 and sodium metaperiodate at pH 5.3. The rate of oxidation as well as the rate of development of dry crease recovery was faster for the latter than for the former. At the same levels of oxidation the fabrics oxidized by the latter method had the higher dry crease recovery. Attempts to explain this difference by using mercerized cotton fabrics were unsuccessful since a reversal of the above effects was obtained with the mercerized fabrics.

Chemical modification of dialdehyde cotton with some monofunctional aldehyde reagents reduces the dry crease recovery properties. Bifunctional aldehyde reagents acted as crosslinkers. The wrinkle resistant properties of dialdehyde cotton fabric modified with hydrazine and dihydrazides were investigated. An improvement in both wet and dry crease recovery of dialdehyde cotton was obtained.

An attempt was made to quantitatively relate the effect of crosslinking dialdehyde cotton to its wet and dry crease recovery properties. In contrast to some published works, a linear relationship between crease recovery and degree of crosslinking based on analysis was not found. Maximum crease recovery was obtained in those cases where every accessible (assuming cotton to be 80% crystalline) anhydroglucose residue is a point of attachment by the crosslinking agent. This conclusion was reached from information obtained on both wet and dry crease recovery data. A series of dihydrazides varying from five to fourteen atoms in length were reacted with dialdehyde cotton fabric. Within the range studied it was found that the length of the crosslink did not significantly affect the degree of crease recovery of the fabric. Hydrazine hydrochloride reacted with dialdehyde cotton fabric forming what is believed to be an azine (-N=N-) crosslink.

In addition to wet and dry crease recovery measurements, other fabric properties such as breaking strength, percent elongation at break, and moisture regain values are discussed.

MULTIPURPOSE FINISHES FOR COTTON BASED ON DIVINYL SULFONE DERIVATIVES

by
Clark M. Welch
Cotton Chemical Reactions Laboratory
Southern Utilization Research and Development Division
New Orleans, Louisiana

The attachment of active hydrogen compounds and active hydrogen polymers to cotton cellulose with simultaneous crosslinking of the cellulose has been demonstrated. A number of divinyl sulfone derivatives have been used as the bonding and crosslinking agents. The sulfones react by a base-catalyzed mechanism, and their application has been carried out by conventional oven-curing procedures. The process permits the attachment of a variety of finishing agents while imparting wash-wear properties. Optical whiteners, dyes, stiffening agents, softeners and water repellents may be attached. These agents may be applied singly or in many different combinations. Of particular interest are synergistic effects arising when new combinations of well-known properties are applied to cotton textiles.

The need for an afterbleach for sulfone-based finishes has been eliminated in certain cases by the incorporation in the treating formulation of trace amounts of sodium borohydride together with a fluorescent whitener. The combination of additives proved considerably more effective than either additive used by itself.

The grafting onto cotton of polyvinyl alcohol as a stiffener has been carried out. A great increase in wet crease recovery over that obtained in the absence of the stiffening agent was noted. On the other hand, the attachment of a softener has increased both the wet and dry crease recovery normally obtained. The latter effects were produced without additional sacrifices in tearing or tensile strength.

While the majority of the active hydrogen materials bonded to cotton contained hydroxyl or amino groups, a silicon-containing polymer having Si-H groups has also been grafted onto cotton to impart water repellency. By means of such processes, fabric has been dyed, softened, made water repellent and rendered wrinkle resistant in a single treatment using one bonding agent.

RADIATION-INDUCED REACTIONS OF COTTON CELLULOSE

by
Jett C. Arthur, Jr., and Florine A. Blouin
Cotton Chemical Reactions Laboratory
Southern Utilization Research and Development Division
New Orleans, Louisiana

To determine whether some useful application of nuclear energy could be made in cotton processing, the mechanism of the interaction of high energy radiation with cellulose was investigated. The major changes were the formation of reducing and acid groups and cleavage of the cellulose chain. The principal gases evolved were hydrogen, carbon monoxide, and carbon dioxide. The presence of glucose, cellobiose, and a homologous series of cellulodextrins was determined. Formation of 2-ketogluconic acid, and possibly 2-ketocellobionic acid, and a similar series of cellulodextrins was indicated.

At lower dosages, where the fibrous properties of cotton cellulose were retained, the presence of activated molecular species, probably free radicals, was indicated by the reaction of vinyl monomers with cellulose both during and after irradiation to yield graft polymers, located within the growth layers and lumen of the fibers. The energy yields of these reactions were dependent on experimental conditions and on prior chemical modification of the cellulose.

Cotton products, having decreased permanent set, decreased stiffness, increased elongation-at-break, and resistance to wetting, were obtained. Cotton yarn, containing radiation grafted polystyrene, showed a very pronounced second order transition temperature at 100° C. Cotton yarn and cyanoethylated cotton yarn, containing radiation grafted polyacrylonitrile, showed a transition at about 80° - 100° C.

A NEW, DURABLE WASH-WEAR FINISH FOR COTTON

by
J. G. Frick, Jr., B. A. Kottes Andrews, and J. David Reid
Cotton Finishes Laboratory
Southern Utilization Research and Development Division
New Orleans, Louisiana

A new crosslinking agent has been developed for the production of wrinkle-resistant and wash-wear cotton fabrics. The agent is a methylol-amide compound, like those agents in common use at present. It can be applied by the procedures presently used but produces a finish with improved durability without sacrificing hypochlorite resistance.

The agent was developed from data obtained in previous work relating the structure of agents and crosslinks to durability. The major factor influencing the durability of a finish is its hydrolysis resistance. The previous work had shown that electronic shifts within the crosslink, toward or away from the amidomethyl group, determined the hydrolysis resistance of the crosslink. Each shift had opposite effects on resistance to acid and alkali. As both acidic and alkaline hydrolytic conditions are met in laundry practice, the electronic shifts need to vary with the hydrolytic medium if best durability is to be obtained.

The new agent is tris(N-methylol2—carbamoylethyl)amine, or the trimethylol derivative of nitrilotripropionamide. The amino group in the agent, and in the crosslink it forms, exists as a free base or as a salt depending on the alkalinity or acidity of the surrounding medium. The electronic shifts, therefore, vary with the medium and do so in a manner to improve the hydrolysis resistance in both acid and alkali.

Magnesium chloride is the preferred catalyst for use with this agent. Acidification of the solution containing the agent is necessary to prevent neutralization of the catalyst by the amine group in the agent itself. With tris(N-methylol2—carbamoylethyl)amine, the acidification required does not cause excessive fabric damage. Strength loss caused by the finishing is approximately the same as caused by finishing with the methylol amide agents now in common use. Not all agents similar to the one described, however, are useful because some do require acidification to an extent that can cause greater fabric damage.

Although the finish contains incompletely substituted amido groups and therefore retains chlorine, the finished fabric does not suffer damage from the regained chlorine in the standard test. This is presumably due to the neutralization of the chlorine acids by the alkaline amino group.

The agent can be prepared easily from inexpensive chemicals. Ammonia, acrylamide and formaldehyde are used in the preparation described.

STRETCH COTTON FABRICS BY SLACK MERCERIZATION

by
W. G. Sloan, Alton L. Murphy, Helen M. Robinson,
and A. S. Cooper, Jr.
Cotton Finishes Laboratory
Southern Utilization Research and Development Division
New Orleans, Louisiana

The recent interest in stretch fabrics has been such that it is somewhat difficult to understand how we have been able to get along without them. This interest includes many types of household and wearing apparel articles as well as industrial uses. If it is possible to make stretch fabrics that meet the service requirements of all these potential users, stretch could become as important as any other textile quality.

Slack mercerization may not produce stretch fabrics that meet all of the quality requirements of many uses, but acceptable products can be produced by this relatively inexpensive process.

When cotton fibers are exposed to caustic solutions of mercerizing strength, the fibers shrink about 15-19%, and become more round with a corresponding increase in cross sectional area. Density is reduced and the crystalline form is changed. These are permanent changes for all practical purposes.

The mercerization of yarn without restrictive tension results in yarn shrinkages of usually more than twice the fiber shrinkage. The additional shrinkage of yarn is apparently due to several factors that can be referred to as yarn crimp. Therefore, in a slack mercerized cotton yarn the reduction in the length of the cotton fibers and the resultant development of yarn crimp are responsible for the stretch properties. Yarn crimp is removed by the application of low loads and the recovery forces are also low when the load is removed. However, recovery of yarn crimp from low loads is essentially complete if a water relaxation step is included in the recovery cycle.

To produce stretchable cotton fabrics with good recovery properties by slack mercerization, it is considered necessary to use conditions that produce maximum fiber shrinkage. A caustic concentration of 23% at 25° C. is considered adequate. Completely relaxed shrinkage in both the warp and filling directions is recommended. If filling stretch only is desired, then the warp is restretched during washing and drying. If both warp and filling stretch are desired, then extremely low warp processing tensions must be used. The application of only 0.25 pounds of warp tension per inch of fabric width significantly reduces the warp shrinkage. If conditions of mercerization are such that the warp is held under tension and the filling permitted to shrink, equal or better filling shrinkage is obtained. However, we believe that these conditions may restrict fiber shrinkage and promote mechanical crimp that has poor recovery characteristics.

The elongation of slack mercerized fabrics up to 20% results in a relatively low permanent set. If a wet treatment, such as home laundering and tumble drying, is included, recovery from deformation is essentially complete. If added resilience or easy care properties are desired, a crosslinking type resin treatment may be used with good results.

PROGRESS REPORT ON THE CARBAMATE WASH-WEAR FINISH

by
J. David Reid and Richard L. Arceneaux
Cotton Finishes Laboratory
Southern Utilization Research and Development Division
New Orleans, Louisiana

In October 1962, a new wash-wear finishing agent, dimethylol ethylcarbamate was described by Arceneaux, Frick, Reid, and Gautreaux. The finish was shown to have high resistance to acid "souring" and chlorine damage in laundering. The finishing agent is prepared under alkaline conditions by the reaction of formaldehyde with ethylcarbamate (urethane). The latter can be prepared by the interaction of urea and ethyl alcohol and is commercially available because of its extensive use as a pharmaceutical. The reactions are as follows:

(1) $C_2H_5OH + NH_2\text{-}\overset{O}{\overset{\|}{C}}\text{-}NH_2 \longrightarrow C_2H_5\text{-}O\text{-}\overset{O}{\overset{\|}{C}}\text{-}NH_2 + NH_3$

(2) $C_2H_5\text{-}O\text{-}\overset{O}{\overset{\|}{C}}\text{-}NH_2 + 2HCHO \longrightarrow C_2H_5\text{-}O\text{-}\overset{O}{\overset{\|}{C}}\text{-}N(CH_2OH)_2$

(3) $C_2H_5\text{-}O\text{-}\overset{O}{\overset{\|}{C}}\text{-}N(CH_2OH)_2 + 2Cell\text{-}OH \longrightarrow C_2H_5\text{-}O\text{-}\overset{O}{\overset{\|}{C}}\text{-}N(CH_2O\text{-}Cell)_2$

The crosslink shown is novel in cellulose chemistry and is unusually stable for a nitrogenous crosslink.

There has been considerable industrial interest in this finishing agent and at least two companies have offered for sale ethyl or methyl carbamate in commercial quantities. Materials cost is about 12¢ lb. on a 50% solution basis. Use of a technical grade of carbamate might lower this cost.

Laboratory evaluation has continued on the carbamate finish. A range of pH's has been studied for the preparation of the dimethylol derivative and an improved product is obtained if a pH of 9.5 to 11 is used. Solutions so prepared and then neutralized are stable over long periods of time, at least for several months. An excess of formaldehyde of about one-half mole gives improved results. Magnesium chloride is the preferred catalyst and a hard cure is desirable.

Additional evidence as to the nature of the crosslink was needed and basic research has been done to substantiate the proposed structure (3). Infrared absorption data have been obtained to show that this crosslink is present in the finished cotton.

Work has been carried out with the dimethylol derivative of methyl, isopropyl, and butyl carbamates and comparison made of the properties of these finishes with that produced by the ethylcarbamate derivative. Both pure and commercial grade carbamates have been investigated.

Curing of the finish on the fabric may be deferred for considerable periods of time. Also, accelerated storage tests show that the finish is remarkably stable even without an afterwash, presumably because of the high resistance of the crosslink to acid hydrolysis.

RESEARCH TO IMPROVE COTTON BATTING

by
H. L. E. Vix, N. B. Knoepfler, and H. K. Gardner
Engineering and Development Laboratory
Southern Utilization Research and Development Division
New Orleans, Louisiana

Cotton batting and padding for many years have been used principally as cushioning in automobile seats, upholstered furniture and mattresses, and to some extent, as stuffing for comforts and quilts. In recent years, foam rubber and polyurethane foams have made great inroads, particularly in the upholstered furniture and automobile markets. This has concerned the groups involved in the marketing of cotton batting and padding. As a result, a research program on improving cotton batting has been underway at SU since July 1961 under a cooperative agreement sponsored by the National Cotton Batting Institute, The Foundation for Cotton Research and Education, The National Cottonseed Products Association and the Textile Waste Association.

The objective of the research is to explore and develop chemical and mechanical means of producing cotton batting made from a mixture of textile waste and linters with better thickness retention, more resilience in both the individual fibers and in the bulk of the fibers, improved cohesiveness and structural stability, higher bulk with less weight, more complete and rapid recovery from deformation loads and a textile product capable of being molded into pads of definite shape, as well as padding material which can be easily shaped, cut, and fitted. Some secondary requirements are fire or flame retardancy, resistance to microorganisms, improvement in color, and freedom of oil and odor.

Specifically, research is directed toward chemical and/or mechanical means of achieving the above improvement by the use of (1) resin or other chemical treatments designed to improve the resilience of the individual fibers and/or the bulk of fibers, (2) adhesives to accomplish the desired amount of dimensional stability and coherence, (3) mechanical or chemical means of crimping, curling, kinking, and interlocking the fibers, and (4) means of achieving a substantial proportion (as much as 25%) of the fibers in the vertical plane. Combinations of these approaches are being investigated to produce the desired product. Research work to date has been conducted on combinations of the first two approaches.

As a result of exploratory work it was evident that it would be necessary to apply chemical treatments to the batting while it still is in the web form. Small scale garnetting equipment was obtained and set in operation so that a spray of the chemical treatment could be applied continuously to the moving web, prior to the formation of the batt. The formed batting is then dried and cured. Some effort has been directed toward low temperature curing.

Resins and latexes were selected which are water soluble or suspendable and which are mutually compatible in solution so that the application can be made in one spraying operation.

Cotton battings of different densities have been made on an experimental basis with improved resilience, coherence and dimensional stability through the application of various resins and latexes using the procedure described above. Immediate recoveries as high as 85-90% have been obtained. In addition, some promising experimental molded cotton batts have been made.

WHAT'S IN THE MILL FOR WOOL

by
Robert E. Whitfield
Western Utilization Research and Development Division
800 Buchanan Street
Albany 10, California

This discussion will review briefly the current status of research and development studies on modification of wool by means of polymer materials, particularly by interfacial polymerization.

During the previous two years reports have been given on progress being made at Western Utilization Research and Development Division on the use of interfacial polymerization as a technique for the chemical finishing of wool. In particular, this method was used for the formation of ultra-thin film of polycondensation type polymers on the surface of the wool fiber. During the past year this technique has moved smoothly from our laboratory into several mills. Just recently we were informed by a large mill with whom we have been cooperating that they are now merchandising washable wool fabrics produced by this process. Several other mills are moving along quite well with their development work and anticipate being in production before too many months. More recently, the interfacial polymerization procedure has been shown to be suitable for use in the treatment of wool top or raw stock. Mill trials are already underway in this area, and initial results are extremely encouraging.

The results obtained in our own research and development program and in cooperation with interested textile companies are of sufficient interest and scope to say now that in interfacial polymerization (IFP) we have a new tool for finishing wool to impart shrinkage control. As was recently announced, now that the IFP treatment is reaching commercial development, we have been asked for a more specific name to describe the interfacially formed polymeric finishes. The name WURLAN was chosen, from Western Utilization Research and Development Division, and Lan, the Latin for wool. Wool treated by the process will, accordingly, be called WURLANized wool.

EFFECT OF SPINNING VARIABLES ON COTTON PRODUCT PROPERTIES

by
John D. Tallant, Louis A. Fiori, Noble H. Groves,
and Audrey V. Castillon
Cotton Mechanical Laboratory
Southern Utilization Research and Development Division
New Orleans, Louisiana

The effect of spinning variables on yarn properties is discussed. It is shown that increasing spindle speeds tend to decrease yarn strength slightly. However, reductions in spinning draft tend to increase yarn strength. When these two findings are considered with the data on spinning efficiency, it is found that, in many cases, for a constant ends down rate reduced draft allows a greatly increased spindle speed. There is evidence that the relationship among spindle speed-spinning efficiency-yarn strength may be more pronounced for cottons with the higher short fiber contents. Alternatively stated, use of low draft seems to make the spinning performance and yarn properties less sensitive to changes in length distribution. This may offer an avenue for the amelioration of changes in length distribution.

For a given cotton and draft it was found that increasing spindle speed decreased yarn breaking elongation probably due to the increased spinning tension engendered by use of a constant traveler number. A lighter traveler increased elongation. This relationship was less marked at the low draft.

Efforts to measure yarn tension directly during spinning were not altogether satisfactory. Therefore, an immersion technique was developed which permitted the accurate determination of the density or degree of packing of the bobbin. It was found that bobbin densities of acceptable spinning yarn could vary from about 0.45 to 0.60 g./cc. This has practical implications since at the higher density a frame would have to be doffed about 33% less often. It was found that the following conditions were conducive to higher bobbin density: lower short fiber content, heavier traveler, increased spindle speeds, and decreased drafts.

EFFECT OF COTTON FIBER PROPERTIES AND SPINNING VARIABLES ON YARN PROPERTIES AND SPINNING PERFORMANCE PART 1. EFFECT OF FIBER STRENGTH [1/]

by

William T. Waters,[2/] Joe Phillips,[2/] and Louis A. Fiori[3/]

The relationship between fiber strength and the spinning variables twist (3.75 and 4.50 T.M.), yarn number (20/1 and 40/1) and spindle speed (9000 to 14,500 rpm) and yarn properties was determined by use of an accelerated type of spinning test (1,2). Selected cottons of low, medium, and high strength were blended to obtain five levels of strength. The blended cottons were processed on a constant processing organization up to spinning. The results indicate that fiber strength has no effect on processing performance up to spinning. Higher strength cottons caused slightly improved spinning performance (in terms of end breakage in spinning) when compared with the performance of lower strength cottons, particularly with lower twist yarns and high spindle speeds. Relative rankings of the effect of the different variables by comparison of the magnitude of mean squares and F ratios show in decreasing order that spindle speed, yarn twist, and yarn size have a greater effect on end breakage in spinning than fiber strength. All three spinning variables were found to have a significant effect at the 99% confidence level, while fiber strength was found significant at the 95% level. At similar twists, coarser yarn numbers can be spun more efficiently at high spindle speeds but not necessarily more efficiently at spindle speeds where end breakage has not reached critical limits.

Fiber strength was found to have no appreciable effect upon yarn evenness and appearance but a statistically significant effect (99% confidence level) on yarn strength. The relationship between fiber strength and yarn strength was linear.

REFERENCES

1. Schultz, E. F., Jr., Little, H. W., Tallant, J. D., Fiori, L. A. "A Statistical Procedure for Determining End Breakage Rate in Spinning." Textile Research Journal 31: 872-874 (1961).

2. Tallant, J. D., Fiori, L. A., Little, H. W. and Leitz, L. A. "Effect of Short Fibers in Cotton on Spinning Performance and Yarn Properties." Textile Industries 124: 8, 129-33 (1960).

1/ A report of work done under contract with the United States Department of Agriculture and authorized by the Research and Marketing Act. This work was supervised by the Southern Utilization Research and Development Division.

2/ School of Textile Technology, Auburn University, Auburn, Alabama.

3/ Cotton Mechanical Laboratory, Southern Utilization Research and Development Division, Agricultural Research Service, United States Department of Agriculture, New Orleans, Louisiana.

THE SRRL RINGLESS SPINNING MACHINE

by
George J. Kyame and Herbert R. Copeland
Cotton Mechanical Laboratory
Southern Utilization Research and Development Division
New Orleans, Louisiana

Basic research at the Southern Utilization Research and Development Division, in developing a new method for converting cotton fibers into yarn, has culminated in the construction of a one-spindle, experimental spinning machine which uses no rings or travelers. In the SRRL Ringless Spinning Machine, fibers drawn from a strand of drafted roving are brought into intimate contact with the twisting free end of a rotating yarn strand. Twist transfers from the yarn strand to the roving fibers causing the fibers to become incorporated within the yarn strand as new, twisting free-end fibers. The yarn strand and its newly-formed increment are drawn away from the zone of fiber intermingling while new roving fibers are advanced to perpetuate the fiber-to-yarn conversion cycle. During the fiber-to-yarn conversion cycle, short fibers and trash particles clinging to the roving fibers are slung off the forming yarn strand by centrifugal action and are ejected forcibly from the spinning chamber. A cleaner yarn results.

The very nature of the spinning process permits the yarn withdrawn from the spindle to be chemically or physically treated and wound simultaneously with the spinning operation into packages of any shape or size desired prior to doffing from the spinning frame. Although the SRRL machine is in the earliest stages of its development, yarn of reasonable quality can be spun at rates comparable to those experienced in conventional spinning. Yarn made on the experimental machine is characterized by excessive twist and short-term yarn diameter fluctuations. It is believed that these faults can be corrected easily. The results of this research are being made public in the hope that industrial and other organizations will complete the development of this radically new method for spinning yarns. Incentives for achieving this goal include among others: (a) the one-step production of yarn packages of any size and shape desired; (b) halving yarn spinning production costs; and (c) doubling, tripling, or possibly quadrupling conventional yarn production rates.

STRETCH AND BULKY COTTON YARNS AND FABRICS THROUGH MECHANICAL AND CHEMICAL TREATMENTS

by
John J. Brown and George F. Ruppenicker, Jr.,
Cotton Mechanical Laboratory
Southern Utilization Research and Development Division
New Orleans, Louisiana

Results of research to develop durable stretch and bulky cotton yarns and fabrics through the use of thermalsetting resins and various mechanical treatments are presented. Methods developed for making bulky, highly stretchable textured cotton yarns are described. The physical properties of the yarns and several constructions of fabrics woven from the yarns are evaluated.

Bulky, highly stretchable textured cotton yarns were produced by treating scoured highly twisted plied yarns with dimethylol ethyleneurea, curing them in this highly twisted state and then backtwisting. When the treated yarns were relaxed they tried to return to the highly twisted state in which they were cured, forming multiple helical coils which gave the yarns their bulk and stretch properties. Textured cotton yarns were produced that had good recovery after being stretched up to 400 percent of their relaxed length. Yarn strength decreased approximately 50% as a result of the chemical and mechanical treatments, but no difficulties were encountered in the ensuing operations of winding, warping, and weaving.

Experimental fabrics having up to 80% elongation-at-break were woven from the textured cotton yarns. Loosely woven constructions were used to allow the textured yarns room to contract. Fabric stretch was controlled by adjusting the number of ends-and-picks per inch and was also dependent on the interlacing of the yarns. The highly stretchable fabrics had good recovery from short-term deformation and those held in an extended position for longer periods of time were restored by wetting-out. The experimental fabrics were also thicker, lower in bulk density, less permeable to air flow and better thermal insulators than comparable fabrics woven from untreated control yarns. Although the breaking strengths of the experimental fabrics were, in some cases, over 50% lower than those of fabrics woven from untreated yarns, abrasion resistance was greater. Reliable tear strength results were unobtainable because of the high stretch properties of the experimental fabrics, but it seems safe to assume that "stretch-type" cotton fabrics would be highly resistant to tearing.

Some of the advantages of fabrics woven from the textured cotton yarns include greater warmth without undue weight, more freedom of movement and better fit. Possible markets would be for sportswear, children's clothes, shirts, dresses, shawls, and men's hose.

THE SRRL NON-LINT TESTER

by
R. A. Rusca and W. A. Latour
Cotton Mechanical Laboratory
Southern Utilization Research and Development Division
New Orleans, Louisiana

The Non-Lint Tester was developed to rapidly determine one of cotton's most important quality factors, trash or non-lint content. Its use should aid researchers in developing improved cotton gin and mill cleaning equipment, and mills in selecting cottons of optimum cleanliness for specific end products and in adjusting textile cleaning equipment for maximum efficiency.

The new Tester is a lickerin-type cleaner with a novel feed system, special cleaning bars that prevent the ejected trash from being re-entrained with the lint, a means for multi-cleaning of the cotton in a continuous process, and an air circulating system that requires no external filter. The machine is designed for either laboratory or mill application, and is fully portable. Operation is simple: A 100-gram sample of cotton is weighed, processed through the machine, and reweighed. The difference between original and final weights is the non-lint content. Ten to twenty determinations per hour can be made, depending on the method of weighing and the speed of the operator.

Evaluations of the Non-Lint Tester indicate a high correlation with the ASTM method that uses the well-known Shirley Analyzer. The degree of correlation between the two methods appears to be unaffected by grade, staple, fiber fineness, and condition of stock, i.e., raw cotton, picker lap, or sliver. The results reveal that the Non-Lint Tester delivers more lint, removes more waste, and has less invisible loss than the Shirley machine. The waste of the Tester contains about twice as much fiber as the Shirley waste, since the fiber in the former waste is not reclaimed.

Further evaluations of the Tester are being carried out by the Cotton Division of the Agricultural Marketing Service, USDA, after which the machine will be made available to the cotton industry.

BIOGRAPHICAL SKETCH

Jett C. Arthur, Jr.

Mr. Arthur, a Texan, has been employed as a research chemist at the Southern Utilization Research and Development Division since 1941. At present he is Head, Radiochemistry Investigations, Cotton Chemical Reactions Laboratory.

Mr. Arthur has a B.A. degree in chemistry and mathematics from Stephen F. Austin State College and an M.A. degree in physical chemistry and chemical engineering from the University of Texas. He has completed graduate work in biochemistry and physics at Tulane University and specialized courses at Princeton University, Massachusetts Institute of Technology, the Oak Ridge Institute of Nuclear Studies, and numerous U. S. Naval Schools.

Mr. Arthur holds an active commission as a Lieutenant Commander, line officer, U. S. Naval Reserve, and during World War II served in the Pacific area, receiving battle stars for invasion-day landings in the Philippine Islands and at Okinawa.

Mr. Arthur has made contributions to the technical literature in physical chemistry, oilseed protein chemistry, food processing, and radiation chemistry of cotton cellulose, including more than 60 articles, patents, and chapters, and about 1250 signed technical abstracts. He is a member of the American Chemical Society and the Sigma Xi.

BIOGRAPHICAL SKETCH

Earl E. Berkley

Dr. Berkley is a native of West Virginia.

He attended Alderson Junior College and later West Virginia University, obtaining his A.B. degree from the latter in 1929. In 1929 and 1930 he attended Washington University on a Lackland Scholarship, receiving an M.S. degree in Plant Physiology. From the same university on an American Creosoting Fellowship he was awarded a Ph.D. with a major in Plant Physiology.

For two years he was employed by the Western Cartridge Company working on cellulose purification for rayon and high explosives; and from 1936 through 1947 he was an employee of the U. S. Department of Agriculture where his work was involved with fiber technology.

In 1948 he transferred to the National Cotton Council as Chief Fiber Technologist; and from 1949 to 1960 was employed by Anderson, Clayton and Company as Director of Fiber and Spinning Laboratory. At present he is Director of Cotton Fiber Research and Testing with the Deering-Milliken Service Corporation.

Author of numerous publications and reports on cotton and other natural cellulose fibers, including wool, he is also a member of various committees of the American Cotton Shippers Association, ACMI, and other technical organizations.

BIOGRAPHICAL SKETCH

John J. Brown

Mr. Brown was born in Gaffney, South Carolina

He received a B.S. degree in Textile Engineering, Clemson College, Clemson, South Carolina in 1924, and did graduate work at North Carolina State College, Raleigh, North Carolina.

He has had thirty-seven years experience in cotton textiles of which thirty-four years have been in research on cotton utilization problems. He is presently Head, Fabric Design Investigations, Cotton Mechanical Laboratory, of the Southern Utilization Research and Development Division. Mr. Brown is author or co-author of 19 publications and two patents. He was a member of a group which received the USDA Superior Service Awards in 1949 for research on cotton tire cord. In 1959, Mr. Brown and Mr. Louis A. Fiori received the USDA Superior Service Award for outstanding achievement in textile engineering research resulting in increased utilization of cotton through the recognition and application of fiber fineness in improving product quality, processing efficiency, and merchandising practices.

He is a member of ASTM Committee D-13 and Scientific Research Society of America.

BIOGRAPHICAL SKETCH

Sydney M. Cone, Jr.

Mr. Cone was born and educated in Maryland, receiving a B.A. degree from John Hopkins University in 1925. He is at present Vice President in Charge of Research at the Cone Mills Corporation, Greensboro, North Carolina.

He is a member of the Executive Committee of the Textile Research Institute, a member of the Technical Advisory Committee of the Southern Garment Manufacturers Association, and has served with distinction in these and other research organizations. He contributed to the war effort as an Industry Member of the War Labor Board in 1944.

Mr. Cone has gained a national reputation as a leader in the textile industry and we are honored to have him serve as general chairman of this conference.

BIOGRAPHICAL SKETCH

A. S. Cooper, Jr.

Mr. Cooper is a graduate of Louisiana Polytechnic Institute in Chemistry. He joined the staff of the Southern Utilization Research and Development Division in 1941 and except for two years in the Army has spent the entire time working on the chemical finishing of cotton textiles. This work includes the application of synthetic elastomers to cotton textiles and the chemical modification of cotton cellulose to improve such properties as heat-, rot-, mildew-, and acid-resistance and thermoplasticity.

At the present time he heads the Weather Resistance Investigations which are primarily concerned with the improvement of cotton textiles for outdoor uses, but also works on the development of chemical finishing processes for commercial use.

BIOGRAPHICAL SKETCH

John P. Elting

Mr. Elting was born in New Mexico, and obtained his grammar and high school education in Denver, Colorado. He obtained a B.S. and later an M.S. degree in Physics from the Massachusetts Institute of Technology, continuing his work toward his doctorate in Physics and Aeronautics to 1934.

Joining the Kendall Company, Bauer and Black, Chicago, Illinois, as a member of the research staff on rubber and colligens, he was transferred to the Textile Division in 1936. In 1939 he assumed his present position as Director of the Research Laboratories, Textile Division.

He is a founder member of The Fiber Society, Textile Quality Control Association, and High Polymer Division of the American Physical Society, and past president of the first two. For four years he was chairman of the ACMI Research Committee; and has served on numerous advisory committees such as the National Resources Planning Board, National Cotton Council, several divisions of the Department of Agriculture, and the Cotton and Cottonseed Marketing Research Advisory Committee.

He is author and co-author of several scientific papers dealing with cotton.

BIOGRAPHICAL SKETCH

John G. Frick, Jr.

Mr. Frick is a native of Louisiana and a graduate of Loyola University of the South and the University of Illinois. At both universities he majored in chemistry.

At present, he is a research chemist at the Southern Utilization Research and Development Division where he has worked for 13 years. His present work is concerned with wash-wear and wrinkle resistance finishes for cotton.

He is a member of the American Chemical Society, the Scientific Research Society of America, and the American Association of Textile Chemists and Colorists.

BIOGRAPHICAL SKETCH

M. Earl Heard

Dr. Heard is well known and admired throughout the textile industry with a distinguished record of service since he received degrees from the Georgia Institute of Technology and Texas Technological College.

He served as Dean of the Philadelphia Textile Institute in the forties and received the honorary degree of Doctor of Textile Science from this Institute in 1958. For a number of years he has been Vice President in Charge of Research at West Point Manufacturing Company.

He is a trustee of the Textile Research Institute and a member of many research organizations.

He has served with distinction in many important posts. Several years ago when President Eisenhower wanted an outstanding man to head the Cotton Task Group, he selected Earl Heard. He carried out the duties of this post with credit to himself and benefit to the cotton industry.

We are very fortunate to have him with us as honorary chairman of this conference.

BIOGRAPHICAL SKETCH

George J. Kyame

Mr. Kyame was born in New Orleans, Louisiana.

He received a B.S. in chemistry in 1933 and an M.S. in physics in 1936 from Tulane University in New Orleans, Louisiana.

He was employed by the Celotex Corporation, Marrero, Louisiana, as research chemist in developing starch-base paint finishes, and later as physicist studying the thermal and acoustical properties of Celotex products.

He joined the staff of the Southern Utilization Research and Development Division in 1942 as physicist engaged in research on the development of new and improved cotton textile processing equipment. Major accomplishments in this field include: a gas-fired, infrared textile slasher; a loom attachment for weaving high-density fabrics; a high-efficiency cleaner for roughly-harvested cotton; and the SRRL Ringless Spinning Machine. He is presently engaged in determining the optimal fabric construction for wash-wear fabrics.

Mr. Kyame is author of several publications and patents, and a member of the Society of the Sigma Xi, American Physical Society, Southeastern Section, and the New Orleans Academy of Sciences.

BIOGRAPHICAL SKETCH

Charles H. Mack

Mr. Mack was born in Philadelphia, Pennsylvania, and attended public and high schools in that area. After a brief period as an accountant, he served for four years in the United States Navy during World War II in the European Theater.

He has a B.S. degree in chemistry and a M.S. degree in organic chemistry from Tulane University. He has been employed as a research chemist at the Southern Utilization Research and Development Division since 1949. At present, he is Project Leader, Exploratory Investigations, Cotton Chemical Reactions Laboratory.

Mr. Mack has made contributions to the technical literature in organic chemistry, chemistry of vegetable oils, and candy and cotton technology, including more than 25 articles and patents. He is a member of the American Chemical Society, American Oil Chemists' Society, and RESA.

BIOGRAPHICAL SKETCH

Mary L. Nelson

Dr. Nelson was born in New Orleans, Louisiana, and educated in the public schools. She received a B.A. degree from Newcomb College and M.S. and Ph.D. degrees from Tulane University.

After four years with the U.S. Forest Service and two years in the Agricultural Marketing Service, she was transferred in 1942 to the Southern Utilization Research and Development Division. Her work has included studies on the acid hydrolysis of cellulose, the crystallinity and "levelling-off D.P." of cotton, collaboration on chemical decrystallization and cross-linking, and physical and chemical aspects of heat damage during ginning of cotton. In 1958 she joined the Plant Fibers Pioneering Research Laboratory, where studies on activation energy of cellulose hydrolysis and on changes in fine structure of cotton fibers during growth have been undertaken.

Dr. Nelson is a member of the American Chemical Society (formerly secretary and presently councilor of the Louisiana Section, served on various committees of the National Council and Cellulose Division); American Association for the Advancement of Science; The Fiber Society; and the honorary societies, Phi Beta Kappa, Sigma Xi, and RESA.

BIOGRAPHICAL SKETCH

Erle V. Painter, Jr.

Mr. Painter has held the position of Director of Research, Johnson and Johnson, Chicago, Illinois, since 1949.

He received his B.S. degree from the University of Texas in 1939, and an M.S. degree in chemical engineering in 1940 from the same university. Additional training was obtained at Southern Methodist and in Boston.

He was employed as assistant in the Field Research Division, Magnolia Petroleum Company, Texas, from 1939 to 1940, and 1942 to 1943, where he also served as assistant director from 1944 to 1946.

In 1946 he became Senior Research Assistant of the Fabric Research Laboratory in Boston, and was promoted to Assistant Director in 1948. In the following year he joined Johnson and Johnson as its Director of Research, and holds this same position today.

During the war period he served as a civilian with the War Production Board in 1941, and served from 1942 to 1945 with the U. S. Army Air Force.

During this interval he acted as chemical engineer on the Cotton Research Committee, 1943-1944; and as chief chemical engineer for the National Cotton Council in 1944-1946.

He is a member of the AAAS, the American Institute of Chemists, Fiber Society, the Institute of Chemical Engineers, and the Textile Institute. His special areas of research include electric discharge cracking of gases, filtration; and in the textile field: work on cotton, plastic laminates, cotton fabrics, and nonwovens.

BIOGRAPHICAL SKETCH

J. David Reid

Dr. Reid is supervisory chemist in charge of the Wash-Wear Investigations group of the Cotton Finishes Laboratory at the Southern Utilization Research and Development Division.

A native of Oregon, Dr. Reid has been with the Department of Agriculture since 1930 and with the New Orleans Laboratory since its inception.

Since 1940, he has worked on the chemical modification and finishing of cotton textiles. This work is described in 112 publications, including 20 patents.

BIOGRAPHICAL NOTES

Ralph A. Rusca

A native of Louisiana, Mr. Rusca graduated in 1932 with a B.S. degree in Physics and Mathematics, and has done extensive graduate work.

As a physicist and mechanical engineer, Mr. Rusca has devoted 25 years in the U. S. Department of Agriculture to research on cotton fiber properties, cotton ginning, and cotton textile processing equipment. He is the author of more than 70 technical papers and patents, and has addressed scientific meetings in the United States and abroad on many occasions.

Mr. Rusca is Head of the Machinery Development Investigations of the Department of Agriculture's Southern Utilization Research and Development Division, New Orleans, in which capacity he has directed the research that led to the development of the well-known "SRRL" textile machines. These include the Opener, Opener-Cleaner, Carding Cleaner, and the Granular Card.

He holds membership in the Scientific Research Society of America, American Society of Mechanical Engineers, The Textile Institute of Great Britain, and other technical organizations.

BIOGRAPHICAL SKETCH

Linton C. Reynolds

Mr. Reynolds graduated from the Georgia Institute of Technology with a B. S. degree in Textile Engineering with an emphasis in Chemistry.

He worked in the Dye Laboratory of General Dyestuff Corporation for one year, then joined the Riegel Textile Corporation where he was employed first as Plant Chemist, Associate Director of Chemical Research, and later as Technical Director of Textile Production, which position he now holds.

He is a member of the American Association of Textile Chemists and Colorists and past Chairman of the Piedmont Section; also a member of the American Chemical Society.

BIOGRAPHICAL SKETCH

Leonard Smith

Dr. Smith was born in Washington, D.C., and obtained primary and high school education there. He received a Bachelor of Science degree in industrial chemistry from the University of Maryland in 1936 and Doctor of Philosophy degree in organic chemistry, from the same institution, in 1941.

After brief employment with the Textile Foundation as a research associate, he was called to active duty as a First Lieutenant, and was relieved from active service in December 1945 with the rank of Lieutenant Colonel. He has since been promoted to the permanent grade of Colonel and holds a mobilization assignment to the Office of the Chief of Research and Development, United States Army General Staff.

Following World War II, he joined the National Cotton Council as Technical Director, a position which he held for three years. He then moved up to his present position, Director of Utilization Research. He is responsible for market research and technical research and service activities relating to the utilization of cotton, cottonseed, and the products derived from them.

He is an official advisor to the Southern Utilization Research and Development Division, Agricultural Research Service, United States Department of Agriculture, and a member of the Board of Trustees, the Textile Research Institute. He is also a member of the American Oil Chemists Society, the AATCC, ACS, AAAS, and the Cosmos Club, of Washington, D. C.

BIOGRAPHICAL SKETCH

John D. Tallant

Mr. Tallant is a physicist at the Southern Utilization Research and Development Division, New Orleans, Louisiana, where he has served for the past fourteen years. He is a native of Louisiana. He holds an Electrical Engineering Degree from Tulane University, and in 1953, he also received a Masters Degree in Physics from the same institution.

His activities at the Southern Laboratory have included physical testing of textiles; instrumentation, such as the development of a thermal transmission tester and the application of a servo system to the Fibrograph; and, more recently, research on the effect of the fiber length distribution in cotton product quality and spinning efficiency.

He is a member of the American Society for Testing Materials and the Scientific Research Society of America. Author of over forty publications, he has presented papers on short fibers and length distribution in general at the past four Cotton Research Clinics.

BIOGRAPHICAL SKETCH

Verne W. Tripp

Mr. Tripp, a native of New Orleans, was educated at Loyola University and the University of Detroit.

He joined the staff of the Southern Utilization Research and Development Division in 1942, and since that time has been associated with a wide variety of research on the chemical and physical properties of cotton. He has published many papers in this field.

He is a member of the Fiber Society, the American Chemical Society, the Electron Microscope Society of America, RESA, and Sigma Xi.

BIOGRAPHICAL SKETCH

H. L. E. Vix

Mr. Vix obtained a B. E. degree in Chemical Engineering at Tulane University, New Orleans, Louisiana in 1934.

Since then he has had twenty-seven years experience in chemical engineering, with industry in consulting engineering,and in research.

He is presently employed as Principal Chemical Engineer, Head Cotton Products Investigation, Engineering and Development Laboratory of the Southern Utilization Research and Development Division. In 1949 he headed the Meal Section, in 1954 he was appointed Supervisor, Process Development Unit, and in 1958 Leader, Cotton Chemical Modification Task Group.

He is author or co-author of 51 publications and patents dealing with research and development of the Southern Division. Has conducted chemical engineering research on product and process developments for cotton, linters, cottonseed, peanut, castor, sesame, other oilseeds, and rice bran.

Mr. Vix is a member of Alpha Chi Sigma, Tau Beta Pi, Scientific Research Society of America, American Chemical Society, American Oil Chemists Society, American Institute of Chemical Engineers, Society of Tulane Engineers, and is a registered professional engineer in Louisiana.

BIOGRAPHICAL SKETCH

William T. Waters

Mr. Waters is an associate professor in the Textile Technology Department at Auburn University, in charge of Textile Research.

His B.S. degree in Textile Engineering was obtained at Clemson College in 1948, and an M.S. in Textile Technology at the Institute of Textile Technology in 1954.

He served in the U. S. Navy as an Ensign from 1943 to 1946 and as a Lieutenant from 1950 to 1952. The period from 1948 to 1950 he was Assistant Overseer of Spinning at the Springs Cotton Mills. During 1952-54 he was employed part time in the Physics Department of the Institute of Textile Technology. He was Assistant Professor of Research, School of Textiles at North Carolina State College from 1954 to 1956.

Mr. Waters was employed as Experimental Assistant to Manager of Textile Research Department at Courtaulds (Alabama) Inc. from 1956 to 1958, and since that time has served in his present position.

BIOGRAPHICAL SKETCH

R. Lee Wayland, Jr.

Dr. Wayland is a native of Virginia and attended the University of Virginia where he received the Ph.D. degree with a major in organic chemistry in 1952.

Since 1951 he has been employed by Dan River Mills, Incorporated, in Danville, Virginia, except for a two-year tour of active duty with the U. S. Army Chemical Corps from 1954 to 1956. At the present time he is an Assistant Director of Research at Dan River.

Dr. Wayland is a member of Sigma Xi, American Chemical Society, and the American Association of Textile Chemists and Colorists; and he is the author of a number of patents and technical papers in the field of chemical finishes for textiles.

BIOGRAPHICAL SKETCH

Robert E. Whitfield

Dr. Whitfield is a native of Tennessee.

A B.S. degree in chemistry was obtained at the University of Tennessee, following which he spent three years as a chemist at Shell Development Company, Research Center, from 1943-1945. From 1946-1949 in graduate study at Harvard University, he received M.A. and Ph.D. degrees in physical organic chemistry.

Following this, two years were spent at American Cyanamid Company and seven years with the Dow Chemical Company, prior to joining the staff of the Western Utilization Research and Development Division.

Research interests have included: mechanisms of organic reactions, synthesis and characterization of polymers, sulfur chemistry, petrochemicals, electronic spectra and structure of organic molecules, and more recently the chemistry of wool.